Technical Support Document: Toxicology Clandestine Drug Labs/ Methamphetamine

Volume 1, Number 10

METHANOL

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Introduction

The clandestine synthesis of methamphetamine (meth) and other illegal drugs is a growing public health and environmental concern. For every pound of meth synthesized there are six or more pounds of hazardous materials or chemicals produced. These are often left on the premises, dumped down local septic systems, or illegally dumped in backyards, open spaces, in ditches along roadways or down municipal sewer systems. In addition to concerns for peace officer safety and health, there is increasing concern about potential health impacts on the public and on unknowing inhabitants, including children and the elderly, who subsequently occupy dwellings where illegal drug labs have been located.

The Office of Environmental Health Hazard Assessment (OEHHA), in cooperation with the Department of Toxic Substances Control (DTSC), has been charged with assisting in identifying and characterizing chemicals used or produced in the illegal manufacturing of methamphetamine, which pose the greatest potential human health concerns. To address in part this growing environmental problem and the need for public health and safety professionals to make appropriate risk management decisions for the remediation of former methamphetamine laboratory sites, OEHHA has developed two types of chemical-specific information documents.

The first set, technical support documents (TSDs), are referenced, multi-page publications, which contain important health and safety data, exposure limits, and key information for recognizing chemicals used or produced during the manufacturing of methamphetamine. These documents will likely be most helpful to health and safety officers, industrial hygienists, or others interested in more detailed toxicological information. The second set, two-page fact sheets, contain much of the same information as the corresponding TSDs; however, the details are presented in a more succinct, graphical format. The fact sheets will be helpful to individuals, including the public, who want to be able to quickly recognize potential chemicals of concern found in illegal methamphetamine labs in order to avoid inadvertent exposures and resulting health impacts.

For more information or to obtain copies of these and other documents, contact:

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I. Chemical Name

A. METHANOL (CH_3OH)

B. Synonyms

Wood alcohol, methyl alcohol, carbinol, columbian spirits, pyroligneous spirit, wood naphtha, wood spirit, HEET®, colonial spirit, methyl hydrate, methyl hydroxide, monohydroxymethane, pyroxylic spirit, methylol.

II. Role in Clandestine Drug Synthesis: Methamphetamine

Methanol is primarily used as a solvent for the extraction of ephedrine from pharmaceutical tablets. It is also used to make methamphetamine from phenyl-2-propanone and methylamine (Turkington, 2000).

III. Chemical Description

A. Appearance

Clear, colorless liquid.

B. Taste

Not available. Taste, like odor, may depend on solvent purity, ranging from alcoholic to pungent or repulsive.

C. Odor

Pure methanol has a faintly sweet or slight alcoholic odor, while crude methanol may be repulsive and pungent (Meditext, 2003).

D. Odor Threshold

The odor threshold is highly variable depending on purity; estimates of 10 ppm to 20,000 ppm have been reported (Meditext, 2003; AIHA, 2002).

E. Irritancy Threshold

Exposure for a period of at least one hour to concentrations of methanol in excess of 200 ppm has been reported to cause eye irritation (AIHA, 2002).

F. Odor Safety Class

C (Amoore & Hautala, 1983); less than 50% of distracted individuals perceive warning of the Threshold Limit Value. *Therefore, odor and irritation are not adequate warnings of overexposure to methanol.*

G. Vapor Density

The vapor density of methanol is 1.1 (air = 1); therefore, methanol vapor is slightly denser than air.

H. Vapor Pressure

92 mmHg at 20° C (AIHA, 2002).

IV. Containers and Packaging

A. Commercial Products

Methanol is used as an industrial solvent; antifreeze for automotive radiators and air brakes; an ingredient in gasoline and diesel oil antifreezes; an octane booster in gasoline; fuel for picnic stoves and soldering torches; a softening agent for pyroxylin plastics; solvent for shellac and some paints and varnishes; a component of paint removers (Hardman et al., 1996); an additive in windshield washing fluid, de-icing solution, duplicating fluids, solid canned fuels, model airplane fuels, embalming fluids, lacquers, and inks (OEHHA, 1999); a denaturant for ethanol (ACGIH, 1991); and as an alternative motor fuel (OEHHA, 2001). Methanol constitutes approximately 3-5% of denatured alcohol.

B. Pharmaceutical Use

No pharmaceutical uses for methanol were identified.

V. Chemical Hazards

A. Reactivity

Methanol is stable under normal conditions of use and storage (Mallinckrodt, 2001).

B. Flammability

Methanol is a moderate explosion hazard and dangerous fire hazard; avoid heat, flames, and ignition sources (Mallinckrodt, 2001). Static electrical discharge may cause ignition of vapors (Mallinckrodt, 2001; Meditext, 2003). Methanol vapors can flow along the ground to distant ignition sources and flash back (Mallinckrodt, 2001). Vapors may also spread and collect in low or confined areas (HSDB, 2002). Containers with methanol residues may be hazardous even when empty (Mallinckrodt, 2001). Non-sparking tools should be used when opening and closing containers of methanol (Meditext, 2003). Methanol may form carbon dioxide, carbon monoxide, and formaldehyde when heated to decomposition. The lower explosive limit and upper explosive limit (by volume) are 6% and 36%, respectively (Mallinckrodt, 2001).

C. Chemical Incompatibilities

Methanol is incompatible with strong oxidizing agents (e.g., nitrates, perchlorates, sulfuric acid), acids (e.g., perchloric acid, nitric acid), acid chlorides, acid anhydrides, alkali metals, reducing agents, and magnesium (Mallinckrodt, 2001; Sigma, 2002; Meditext, 2003). Methanol may react with metallic aluminum at high temperature generating hydrogen gas. Methanol also attacks some plastics, rubber, and some coatings (Meditext, 2003).

VI. Health Hazards

A. General

Methanol is readily absorbed following ingestion, inhalation, or dermal exposure, and the toxicity is the same regardless of the route of exposure (Reprotext, 2003; OEHHA, 1999). It is a mild eye, respiratory tract, and mucous membrane irritant (Reprotext, 2003). Methanol is also a defatting agent causing skin to become dry and cracked (Mallinckrodt, 2001). Signs of systemic poisoning may be delayed 8-36 hours after initial exposure (Hardman et al., 1996). It can cause permanent damage to the optic nerve and central and peripheral nervous system with just a single acute exposure. Methanol can also have cumulative toxicity with repeated exposures (Reprotext, 2003). Visual disturbances and metabolic acidosis are characteristic of methanol

poisoning, which can lead to coma, respiratory or circulatory arrest, and death (ACGIH, 1991; Hazardtext, 2003). Visual disturbances include dilated or un-reactive pupils, dim vision, and bilateral blindness, which is usually permanent (Hardman et al., 1996). Other signs and symptoms of methanol poisoning include headache, vertigo, vomiting, severe upper abdominal pain, back pain, difficulty breathing, cold extremities, narcosis, prostration, lethargy, and in-coordination (ACGIH, 1991; Hardman et al., 1996). The most common permanent consequences following severe poisoning are optic neuropathy, blindness, Parkinsonism, toxic encephalopathy (degenerative brain disease), and polyneuropathy (a disease process involving several peripheral nerves) (Meditext, 2003). Additional signs and symptoms resulting from acute methanol poisoning include roaring in the ears, insomnia, symptoms similar to ethanol "hangover," anorexia, vertigo, nerve inflammation (neuritis), degenerative brain disease (acute encephalopathy), and hemorrhagic necrosis in several regions of the brain, inflamed pancreas (acute necrotizing pancreatitis), disintegration of muscle (rhabdomyolysis), confusion, lethargy, diarrhea, constipation, and death (Merck, 1996; Reprotext, 2003; Meditext, 2003).

B. Acute Effects

Toxic effects from acute methanol exposure may occur by ingestion, inhalation, or dermal absorption (Meditext, 2003). Acute methanol poisoning has three stages: 1) a rapid narcotic effect involving drowsiness or fatigue, and mild irritation of the eyes and mucous membranes 2) a latent period of 10-48 hours, followed by 3) more severe CNS effects including nausea, vomiting, dizziness, headache, abdominal and muscle pain, weakness, disturbances of consciousness, and visual disturbances, accompanied by metabolic acidosis (accumulation of acid in the body) and deep respirations (Reprotext, 2003; TOXLINE, 1997).

Nervous System: Loss of coordination (ataxia), shock, convulsions, seizures, coma, and hyperactivity of the deep tendon reflexes can result from methanol poisoning (Reprotext, 2003; Merck, 1996; Meditext, 2003). The last stage of acute methanol poisoning may cause permanent effects (i.e., damage to central, motor, and optic nerves), even from a single exposure (Reprotext, 2003). The most common permanent consequences following severe poisoning are optic neuropathy, blindness, Parkinsonism, toxic encephalopathy, and polyneuropathy. Permanent Parkinsonian-like syndrome, which usually does not appear until several months to two years after methanol exposure, has been described (Meditext, 2003).

Circulatory system and heart: Signs and symptoms resulting from acute methanol poisoning include high ammonia level in the blood (hyperammonemia), circulatory collapse, rapid heartbeat (tachycardia), slow heartbeat (bradycardia), cardiac failure, severely low blood pressure (hypotension), low magnesium content in the blood causing neuromuscular irritability (hypomagnesemia), low potassium content in the blood characterized by neuromuscular disorders (hypokalemia), decreased phosphates in the blood (hypophosphatemia), increase in the number of leukocytes in the blood (leukocytosis), coagulation disorder, and abnormal increase of blood sugar (hyperglycemia) (Meditext, 2003; Reprotext, 2003; Merck, 1996). Metabolic acidosis may be delayed for 18-24 hours, or longer if methanol has been ingested in combination with ethanol (Meditext, 2003).

Kidneys: Symptoms of acute methanol poisoning may include cessation of urine excretion (anuria), acute renal failure, and blood in the urine (hematuria) (Meditext, 2003; Reprotext, 2003).

Eyes: If methanol is splashed into the eyes, it may cause rapid eye movements (nystagmus) and dilated pupils (mydriasis) (Reprotext, 2003). Visual disturbances generally develop between 12-48 hours after ingestion, and range from mild photophobia and blurred vision to complete blindness (TOXLINE, 1997).

Skin: Skin contact with methanol may cause itching, eczema, and dermatitis (Reprotext, 2003).

Respiratory: Inhalation of acutely toxic concentrations of methanol vapor may cause respiratory failure, rapid respiration (tachypnea), difficulty breathing (dyspnea), abnormally rapid and deep breathing (hyperventilation), cessation of breathing (apnea), and accumulation of fluid in the lungs (pulmonary edema) (Meditext, 2003; Merck, 1996).

C. Chronic Effects

Methanol can have cumulative toxicity with repeated exposures. Methanol is a defatting agent and can cause dermatitis with dryness and cracking upon repeated skin exposure (Reprotext, 2003). Other symptoms of chronic exposure include eye irritation, headache, giddiness, insomnia, gastrointestinal problems, and especially visual difficulties (Reprotext, 2003; OEHHA, 2001). Effects from chronic exposure are similar to, but less severe than, those occurring after acute exposure (OEHHA, 2001).

D. Skin Contact

Methanol is a defatting agent and direct contact may cause skin to become dry and cracked. Methanol can be absorbed through the skin causing symptoms of systemic toxicity similar to those experienced with inhalation exposure (Mallinckrodt, 2001). Repeated skin contact with methanol can result in visual disturbances and blindness (ACGIH, 1991).

E. Eye Contact

Direct eye contact with methanol may result in mild irritation, pain, swelling, tearing, and sensitivity to light (photophobia) (Meditext, 2003).

F. Inhalation

Methanol is slightly irritating to mucous membranes. Inhalation may cause headache, drowsiness, nausea, vomiting, blurred vision, blindness, coma, and death (Mallinckrodt, 2001). See section VII, B (Acute Effects) for additional signs and symptoms.

G. Ingestion

Ingestion is the most common route of accidental poisoning (Reprotext, 2003). Abdominal pain, anorexia, nausea, and vomiting may occur after ingestion. Acute necrotizing pancreatitis has been reported in severe poisonings (Meditext, 2003). See section VII, B (Acute Effects) for additional signs and symptoms (Mallinckrodt, 2001).

H. Predisposing Conditions

Pre-existing skin disorders, eye problems, respiratory problems, neurological conditions, or impaired liver or kidney function may predispose individuals to the adverse effects of methanol (Mallinckrodt, 2001; OEHHA, 1999). Concurrent exposure to formaldehyde or formic acid may increase sensitivity, while prior ingestion of ethanol may decrease sensitivity to the effects of methanol (OEHHA, 1999).

I. Special Concerns for Children

Children have a greater ratio of lung surface area to body weight as compared to adults. Similarly, the ratio of respiratory minute volume to body weight is greater in children than adults. Therefore, at any given concentration of methanol in air, children will probably receive a larger

dose than adults will. In addition, the vapor density of methanol is greater than that of air. Therefore, higher concentrations of methanol are likely to be found closer to the ground. Children may be exposed to higher concentrations of methanol gas than adults because of their short stature. Children may be more susceptible to the toxic effects of methanol because they are often less likely to leave an area where a release has occurred.

VII. First Aid

A. Eyes

Immediately flush eyes with water for at least fifteen minutes, lifting lower and upper eyelids (Mallinckrodt, 2001). If irritation, pain, swelling, lacrimation, or photophobia persists, obtain medical attention (Meditext, 2003).

B. Skin

Immediately flush skin with water for at least fifteen minutes. Obtain medical attention. Remove contaminated clothing and shoes. Wash clothing and thoroughly clean shoes before reuse (Mallinckrodt, 2001).

C. Ingestion

It is unclear whether or not to induce vomiting. In cases of severe poisoning, give ethanol, as it partially inhibits the formation of toxic metabolites of methanol. Obtain medical attention immediately (Meditext, 2003).

D. Inhalation

Seek fresh air. If not breathing, give artificial respiration, and if breathing is difficult, give oxygen. In cases of severe poisoning, give ethanol, as it partially inhibits the formation of toxic metabolites. Obtain medical attention immediately (Mallinckrodt, 2001; Meditext, 2003).

VIII. Standards for Inhalation Exposure

A. Occupational Exposure Limits (NIOSH, 1997; ACGIH, 1994)

1. Ceiling Limit (C) (not to be exceeded at any time): Not established.

2. Short-Term Exposure Limit (STEL or ST): 250 ppm (325 mg/m^3)[skin]

3. 8-Hour Time Weighted Average (TWA): 200 ppm (260 mg/m^3)

4. 10-Hour Time Weighted Average (TWA): 200 ppm (260 mg/m^3)

5. Immediately Dangerous to Life & Health (IDLH): 6000 ppm (7860 mg/m^3)

Important Definitions Follow:

Ceiling Limit (C) is a concentration that must not be exceeded during any part of the workday.

Short-Term Exposure Limit (STEL or ST) is a 15-minute time-weighted average concentration that should not be exceeded during any part of the workday.

8-Hour Time Weighted Average (8-hour TWA) concentration is an exposure standard that must not be exceeded during any 8-hour work shift of a 40-hour workweek. 8-Hour TWA exposure standards established by the Occupational Safety and Health Administration (OSHA) are called Permissible Exposure Limits (PELs). 8-Hour TWA exposure standards established by the American Conference of Governmental Industrial Hygienists (ACGIH) are called Threshold Limit Values (TLVs).

10-Hour Time Weighted Average (10-hour TWA) concentration is an exposure standard that must not be exceeded during a 10-hour workday of a 40-hour workweek. 10-Hour TWA exposure standards developed by the National Institute for Occupational Safety and Health (NIOSH) are called Recommended Exposure Limits (RELs).

Immediately Dangerous to Life & Health (IDLH) defines a concentration which poses a threat of death or immediate or delayed permanent health effects, or is likely to prevent escape from such an environment in the event of failure of respiratory protection equipment. IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH).

"Skin" notation (NIOSH): significant uptake may occur as a result of skin contact. Therefore, appropriate personal protective clothing should be worn to prevent dermal exposure.

B. Emergency Response Planning Guidelines (1 hour or less) (AIHA, 2002)

1. ERPG-1 (protective against mild, transient effects): 200 ppm
2. ERPG-2 (protective against serious adverse effects): 1000 ppm
3. ERPG-3 (protective against life-threatening effects): 5000 ppm

NOTE: There is a significant discrepancy between the IDLH concentration (6000 ppm) and the ERPG-3 concentration (5000 ppm). Both values are intended to provide an estimate of a life-

threatening concentration. OEHHA recommends using the ERPG-3 value as an estimate of a potential lethal concentration.

Emergency Response Planning Guidelines (ERPGs) are developed by the American Industrial Hygiene Association (AIHA) to assist in planning and preparation for catastrophic accidental chemical releases. ERPGs allow emergency response planners to estimate the consequences of large-scale chemical releases on human health, and evaluate the effectiveness of prevention strategies and response capabilities. ERPGs assume that the duration of exposure is one hour or less. They are not intended to be used as limits for routine operations and are not legally enforceable.

Definitions for the three ERPG levels are:

ERPG-1: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

ERPG-2: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

ERPG-3: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

C. Acute Reference Exposure Level (1-hour exposure) (OEHHA, 1999)

Level protective against mild adverse effects: 21 ppm (28 mg/m^3)

D. Chronic Reference Exposure Level (multiple years) (OEHHA, 2001)

Level protective of adverse health effects: 3 ppm (4 mg/m^3)

Reference Exposure Levels (RELs) are developed by the California EPA's Office of Environmental Health Hazard Assessment (OEHHA). A REL is a concentration at or below which no adverse health effects are anticipated, even in the most sensitive members of the general population (for example, persons with pre-existing respiratory disease). RELs incorporate uncertainty factors to account for information gaps and uncertainties in the toxicological data. Therefore, exceeding a REL does not necessarily indicate an adverse health impact will occur in an exposed population. Acute RELs are based on an assumption that the duration of exposure is one hour or less. Chronic RELs are intended to be protective for individuals exposed continuously over at least a significant fraction of a lifetime (defined as 12 years).

E. Chronic Reference Concentration (lifetime exposure) (IRIS, 2001)

Level protective of adverse health effects: Not established.

IX. Environmental Contamination Concerns

A. Surface Water

Methanol readily biodegrades in water with a half-life between one and ten days (Mallinckrodt, 2001). Volatilization half-lives for a model river (1m deep) and an environmental pond have been

estimated at 4.8 days and 51.7 days, respectively. Volatilization from surface waters may be significant based upon Henry's Law constant (HSDB, 2002). Bioaccumulation is not expected to be significant in aquatic organisms; methanol is only slightly toxic to aquatic organisms (OPPT, 1994).

B. Groundwater

Methanol has the potential to leach into groundwater, but significant contamination is unlikely given the rapid rate for biodegradation (Mallinckrodt, 2001).

C. Drinking Water

Suggested No Adverse Response Level (NAS, 1980): Not established.

Preliminary Remediation Goal for Tap Water (U.S. EPA, 2002 Region IX): 18 mg/l

D. Soil

Methanol is expected to biodegrade and evaporate from soil (Mallinckrodt, 2001). It is also expected to have high mobility in soil based on its miscibility in water and log K_{ow} (-0.77) (HSDB, 2002).

Preliminary Remediation Goal for Residential Soil (U.S. EPA, 2002 Region IX): 31,000 mg/kg

E. Air

Methanol is degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals with a half-life between ten and thirty days (Mallinckrodt, 2001). This reaction produces formaldehyde. In polluted air, methanol can also react with nitrogen dioxide to form methyl nitrite. Methanol is a volatile organic compound (VOC) that can contribute to the formation of photochemical smog in the presence of other VOCs (OPPT, 1994). Physical removal from the atmosphere can occur via rainfall, i.e., wet deposition. At ambient temperature, methanol is expected to exist almost entirely in the vapor phase (HSDB, 2002).

Preliminary Remediation Goal for Ambient Air (U.S. EPA, 2002 Region IX): 1.8 mg/m^3

F. Indoor Surface Contamination

Methanol has a high vapor pressure indicating that rapid evaporation from surfaces will occur (HSDB, 2002).

X. Personal Protective Equipment

Avoid prolonged or repeated exposure with eyes and skin, especially skin that has been cut or scratched (Sigma, 2002). Wear gloves (Butyl, Teflon, Viton, PE/EVAL), impervious boots (Butyl, Teflon), chemical safety goggles, and coveralls (Saranex, Responder, Trellchem, Tychem) (Mallinckrodt, 2001; NIOSH, 2001B). Wash skin exposed to methanol and immediately remove any methanol soaked clothing (NIOSH, 1997). Do not wear contact lenses when working with methanol (HSDB, 2002). If ambient concentrations of methanol exceed the 200ppm Threshold Limit Value, wear a positive pressure self-contained breathing apparatus (SCBA) (NIOSH, 2001A; Mallinckrodt, 2001).

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